Irreversible electroporation-induced sciatic neuropathy observed with intraoperative somatosensory evoked potential monitoring

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Background
When tumors involve nerves, surgical resection may lead to nerve sacrifice. Consequently, newer techniques are in constant development along with use of intraoperative neuronomonitoring. Irreversible electroporation (IRE) uses electrical pulses across cells to generate destabilizing electric potential, forming defects in cell membrane leading to cell death.1-3 It is most effective in tissues with high density of cell wall structures, potentially avoiding destruction of nerves, connective tissue or vessels.1,2

Case presentation
A 41-year-old woman with 2-year history of rectal adenocarcinoma, presented for image-guided ablation of a persistent right pelvis adenocarcinoma. She received chemotherapy/radiation then underwent abdominopерineal resection, pelvic exenteration and brachytherapy. Despite this, she had twice-recurrent right pelvis neoplasms with tethering of small bowel. Due to sciatic nerve proximity, she underwent IRE ablation operatively, patient had no symptoms in peroneal nerve distribution despite transient SSEP decrease, which showed full recovery at procedure end. However patient had numbness in right posterior thigh and right S1-S2 dermatomes, 5-10 strength on right foot eversion, absent right ankle reflex and 1+ left ankle reflex. Nerve conduction studies showed decreased right sural sensory amplitude compared to left (0.8 vs. 1.34µV). Electromyography of right medial gastrocnemius showed reduced recruitment. This was consistent with partial involvement of right sciatic nerve and adjacent posterior cutaneous nerve of thigh.

Results
Four sessions of IRE were delivered. Each ablation was accompanied by P37 amplitude decrement of SSEP. First three decrements recovered to baseline after pausing IRE. Fourth episode had only partial recovery to less than 50% amplitude at 0.96µV. Third decrement was associated with PSEP decrease, which recovered to baseline amplitude at procedure completion (Figure 2).

Post-operatively, patient had no symptoms in peroneal nerve distribution despite transient SSEP decrement, which showed full recovery at procedure end. However patient had numbness in right posterior thigh and right S1-S2 dermatomes, 5-10 strength on right foot eversion, absent right ankle reflex and 1+ left ankle reflex. Nerve conduction studies showed decreased right sural sensory amplitude compared to left (0.8 vs. 1.34µV). Electromyography of right medial gastrocnemius showed reduced recruitment. This was consistent with partial involvement of right sciatic nerve and adjacent posterior cutaneous nerve of thigh.

Discussion
• This is the first report regarding use of intraoperative neuronomonitoring for IRE as well as use of IRE in rectal cancer.
• In pig and rat models of IRE directly applied to sciatic nerve, basal lamina or endoneural integrity was unaffected but axon was damaged.1-2 After 7 weeks, function was regained and NCV and CNAP restored.1 Nerves treated with IRE can attain full recovery, whereas nerves in thermal ablative zones cannot regenerate.1-2
• Utility of SSEP monitoring is to warn the operator at earlier, reversible stages of nerve injury, possibly preventing permanent damage.
• Our patient experienced mild weakness and numbness post-operatively, consistent with mild sciatic neuropathy. Six weeks afterwards, she progressively regained sensation and strength until close to baseline. This is consistent with findings from animal studies, but further human studies are required.
• Intraoperative neuronomonitoring is valuable to IRE due to real-time feedback and potentially improves outcomes by preventing permanent nerve damage. Despite tumor involving tissue adjacent to nerve, ablation is possible with temporary neuromonitoring.